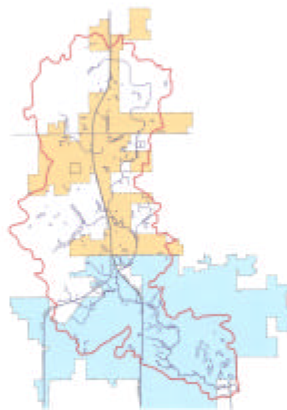
Project Summary and Key Findings

Cool Creek Watershed Management Plan



August 2003

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INTRODUCTION

Concerns over future development in the upper watershed and water quality led to the evaluation of stormwater management in the Cool Creek watershed.

The Cool Creek Watershed drains significant portions of the City of Carmel and Town of Westfield. The watershed boundary and corporate boundaries for Carmel and Westfield are illustrated in Figure 1. The watershed drains approximately 23.7 square miles, beginning at approximately 199th Street and draining south and southeasterly, discharging into the White River south of 116th Street. U. S. 31 runs through the center of the watershed. The Westfield portion of the watershed contains both urbanized areas as well as significant tracts of undeveloped land (primarily agricultural). The Carmel portion of the watershed is fully urbanized. Portions of the watershed lie in unincorporated Hamilton County, but are subject to potential annexation in the future.

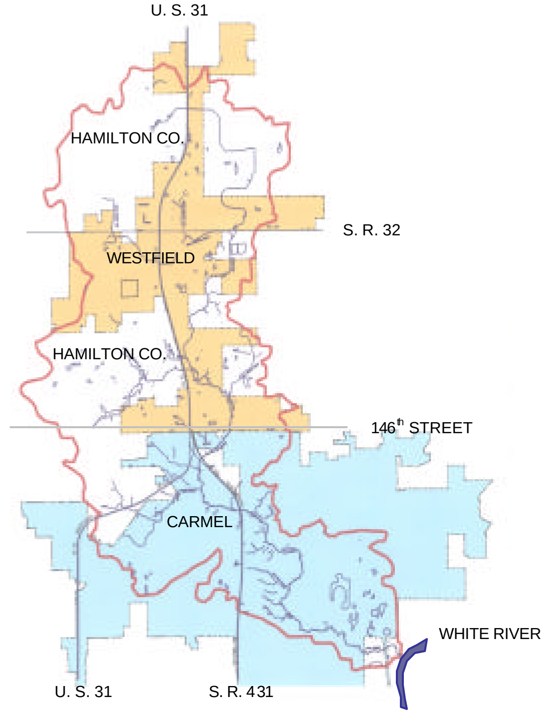


Figure 1 – Cool Creek Watershed

New state and federal regulations require Hamilton County, Carmel and Westfield to address the quality of stormwater runoff.

Recently, there has been growing interest and concern regarding stormwater management practices and their effectiveness in controlling the quantity *and quality* of stormwater runoff. This issue is of special concern given rapid growth in the Westfield area and pending requirements from United States Environmental Protection Agency (US EPA) and the Indiana Department of Environmental Management (IDEM).

New federal regulations promulgated by the US EPA and administered by IDEM require Hamilton County, Carmel, and Westfield (and other communities throughout the country) to improve the quality of stormwater runoff. Stormwater runoff is a

Controlling stormwater runoff from new development, both during and after construction, will be an important element in improving water quality.

leading source of stream impairment due to pollutants that collect on parking lots, streets, highways, commercial, industrial and residential areas and wash off during rain events. These new regulations will require communities to educate and involve the public on stormwater quality issues, minimize erosion from construction sites, improve the long-term quality of stormwater being discharged from new developments, and have good municipal housekeeping operations to minimize stormwater pollution.

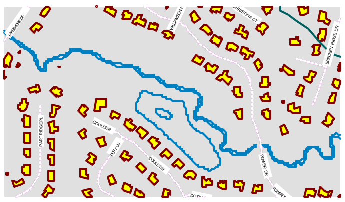
Hamilton County (through the County Surveyor's Office), Westfield and Carmel entered into an agreement in 2001 to complete a thorough evaluation of stormwater management in the watershed. Clark Dietz, Inc. was retained to develop a Cool Creek Watershed Management Plan that includes recommendations to correct existing stormwater problems and prevent future problems from occurring as the watershed continues to develop. The following is a summary of the scope of work for the project:

Inventory and Problem Identification	This work element included data collection and evaluation, staff interviews, public meetings, field reconnaissance, and problem identification.
Problem Analysis	This work element included hydrologic/hydraulic analysis and an evaluation of water quality issues in the watershed.
Solution Development	Alternative solutions were developed and evaluated under this task. Solutions ranged from bridge and culvert replacements, streambank stabilization projects, to regional detention facilities.
Conclusions and Recommendations	This work element summarized overall findings from the study and recommendations for capital projects as well as changes in stormwater management practices in the watershed.

INVENTORY AND PROBLEM IDENTIFICATION

Numerous sources of information were used to provide baseline data for the project. These sources consisted of maps and plans, previous reports and studies, ordinances and standards, and other regulatory information.

Maps and Plans



GIS data from Hamilton County were used extensively on the project

Maps and plans used on the project included:

- Geographic Information System (GIS) Maps
- USGS Maps
- National Wetland Inventory Maps
- Flood Insurance Rate Maps
- Zoning Maps
- Aerial Photographs

The maps were used to identify drainage patterns, existing and future land use, wetlands, floodplains, and other watershed characteristics.

Previous Reports and Studies

The following reports and studies were used to assist in the development of hydrologic and hydraulic analyses of the watershed:

- Indiana Department of Natural Resources (IDNR) Department Memorandum on Grassy Branch Re-Study, July 12, 2001
- Hydraulic Report for Village Farms Wilfong, July 10, 1996
- Countryside Overall System Drainage Report, August 1, 2001
- Soil Survey of Hamilton County, Indiana, U. S. Department of Agriculture Soil Conservation Service, November 1978
- Flood Insurance Studies, City of Carmel – November 1980, Town of Westfield – September 1980, and Hamilton County Unincorporated Areas – January 1987.

The Flood Insurance Studies (FIS) referenced above were being updated by the IDNR during the course of the project. The updated mapping resulting from the revised FIS was incorporated into this project.

Ordinances and Standards

Hamilton County, Westfield, and Carmel ordinances and site design standards were reviewed as they pertain to stormwater management. Carmel and Westfield both follow the Hamilton County standards, which is a key advantage in terms of providing consistent stormwater management controls in the different jurisdictions in the watershed.

Stormwater ponds control peak flows from new development.

Local site design standards require developers to provide detention facilities (ponds) that temporarily restrict stormwater runoff created by new impervious surfaces (e.g. roadways, sidewalks, rooftops) that are constructed in new developments. Ponds must be designed to limit stormwater discharge for both large and small storms. Developers are currently required to construct detention ponds that collect water from their respective developments and restrict the peak discharge to a magnitude below the pre-development condition.

Many ponds in new developments have a permanent pool of water that remains after a storm event. These ponds (often referred to as *wet ponds*) provide some water quality benefit. However, design standards for these types of ponds need to be upgraded to provide better water quality enhancement performance and protect downstream channels.

Hamilton County also has an ordinance that prohibits fill in the floodplain of any drainageway. This is a proactive requirement in that it preserves natural flood storage and also protects water quality. Carmel and Westfield (and many other communities in Hamilton County) allow development within the floodplain, provided that it meets certain standards to prevent flooding.

Problem Identification

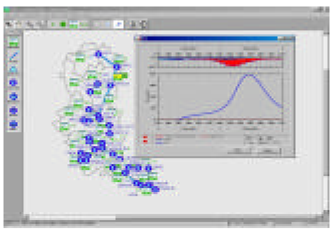
Input from the public helped identify problems and areas of concern.

Existing stormwater problems in the Cool Creek watershed were identified using several sources, including interviews with local staff, input obtained at public meetings and through feedback from citizens, problems identified in previous studies and reports, and problems noted during field reconnaissance.

Interviews with staff from Hamilton County, Carmel and Westfield were conducted in spring 2002 to obtain historical information on drainage and flooding problem areas. Maps were annotated to show various stream flooding areas and local drainage concerns. Public meetings were held in Westfield and Carmel in May 2002 to receive input from citizens on specific problem areas or areas of concern. Field reconnaissance along all of the major stream reaches was conducted during the spring and summer of 2002. Photographs were taken documenting areas of streambank erosion, log jams, floodplain encroachments and other problem areas.

The above information was compiled on a Problem Area Map, which is illustrated on Figure 2 (following page). This map shows the locations of neighborhoods with drainage concerns, stream reaches with debris blockages and/or erosion problems, inadequate bridges/culverts, and other information obtained during the problem identification phase.

PROBLEM ANALYSIS

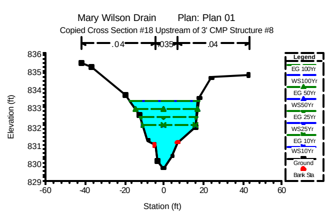


A hydrologic model, HEC- HMS, is used to simulate the rainfall runoff process.

The problem analysis phase included a hydrologic/hydraulic analysis of the watershed and an evaluation of water quality issues in the watershed. The following sections describe the results of these analyses.

Hydrologic/Hydraulic Analysis

Problems were identified and analyzed using hydrologic/ hydraulic computer models. These models simulate the rainfall runoff process and predict the volume and rate of flow that occurs during different storm events. The models are used to predict locations with flooding problems, define floodplain and floodway boundaries, and to determine appropriate solutions.



A hydraulic model, HEC-RAS, is used to predict flood elevations along the creek.

The hydrologic model was also used to simulate the cumulative effects of future development in the watershed and evaluate the appropriateness of current stormwater management requirements. As mentioned previously, developers must provide detention facilities that restrict stormwater discharge from large and small rainfall events.

The results of this analysis are illustrated in Figure 3 below which compares existing conditions (blue) and "full build-out" conditions with current detention standards (magenta). The flow vs. time graphs (hydrographs) represent the 100-year and the 1-year storms (24-hour duration) and are located at 146th Street.

** 100-year storm: A 24-hour rainfall depth that has a 1/100 (1%) chance of being exceeded in any given year*

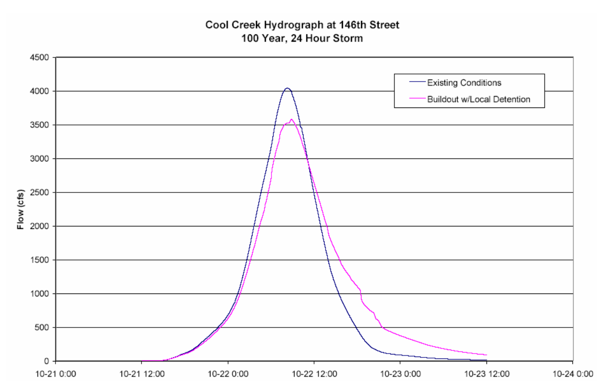
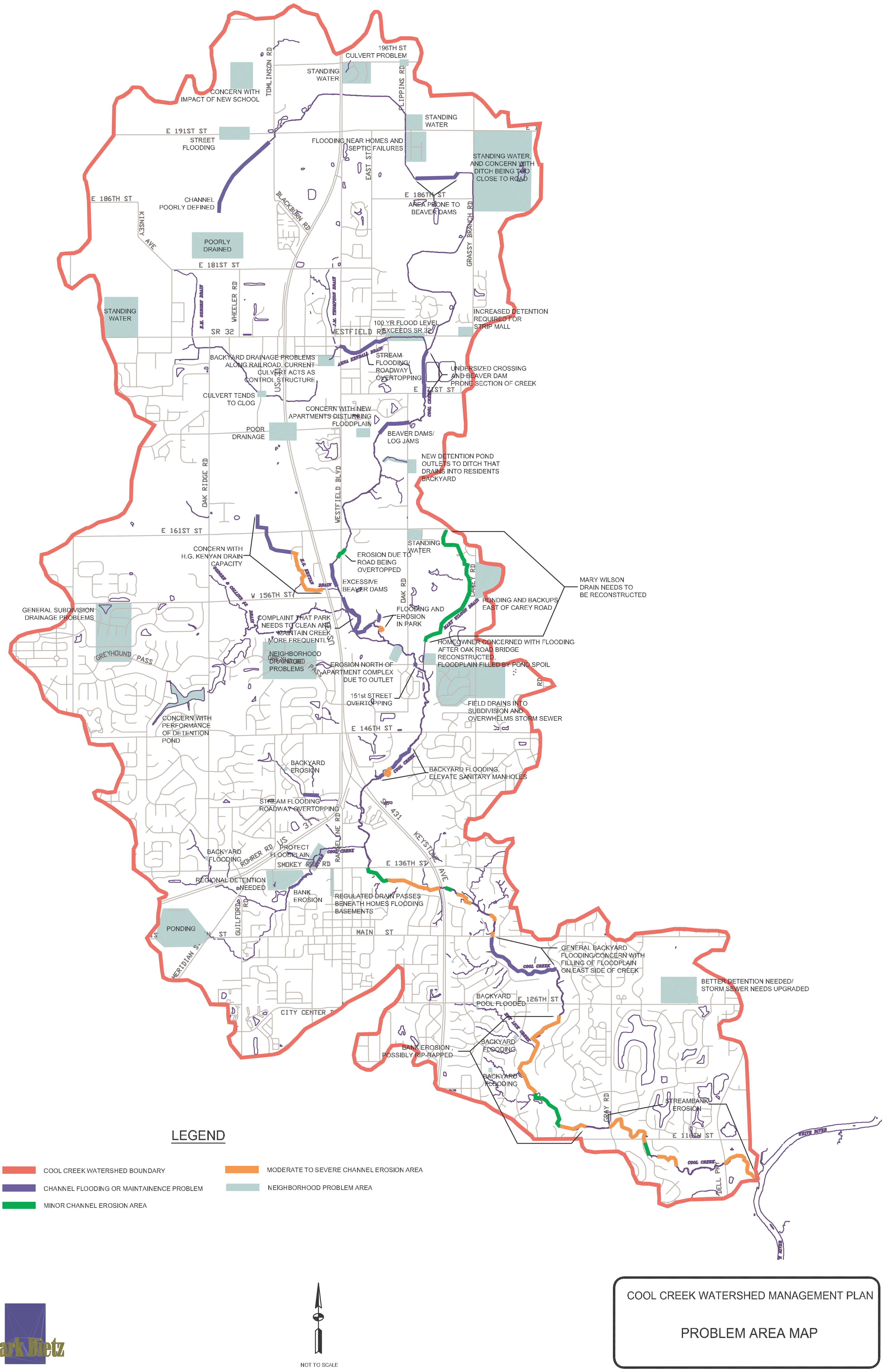


Figure 3 (1 of 2)
Hydrologic Impact of Future Development – 100-Year Storm*



COOL CREEK WATERSHED MANAGEMENT PLAN

PROBLEM AREA MAP

Current detention standards are effective in controlling peak flows, but longer duration flows may lead to downstream channel erosion.

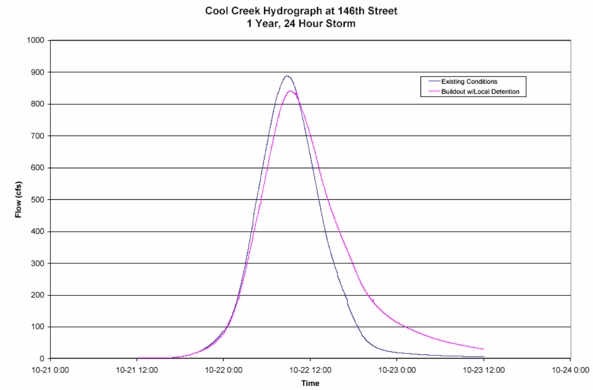


Figure 3 (2 of 2)
Hydrologic Impact of Future Development – 1-Year Storm

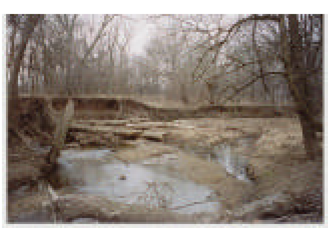
** 1-year storm: A 24-hour rainfall depth that has a probability of 1/1 (100%) of being exceeded in any given year*

The hydrologic analysis shows that current detention standards will be effective in controlling peak flow rates and corresponding flood elevations. However, these hydrographs also illustrate the impact of urbanization on the *volume and duration* of stormwater runoff. Under developed conditions, peak flow is reduced but it takes longer for flows to recede.

Cool Creek Upstream of 116th Street in Golf Course

Urbanization can alter the geometry and stability of stream channels. Larger and more frequent discharges that accompany watershed development cause downstream channels to enlarge, whether by widening, downcutting, or a combination of both. This is occurring in the lower reaches of Cool Creek as illustrated in the photos to the left.

Recent research has shown that traditional approaches in controlling runoff are not always effective with respect to channel stability in urbanizing areas. While the magnitude of the peak flows may not change from pre- to post-development, the duration of erosive flow increases (as was illustrated on Figure 3 above). This longer duration flow can exacerbate channel erosion.



Cool Creek Upstream of White River confluence

Newer approaches require more control (i.e. a larger required storage volume) than traditionally has been allocated to detention pond design. The premise of this approach is that runoff will be stored and released so gradually that critical erosive velocities will seldom be exceeded in downstream channels.

Channel protection from future development should be seriously considered in the Cool Creek watershed. Channel enlargement in urbanizing streams can have significant economic and ecologic implications. Studies have shown that channel enlargement can severely degrade the quality of instream habitat and diversity of aquatic species.

Water Quality Evaluation

A water quality evaluation was performed as part of the Cool Creek Watershed Management Plan. This task included a review of the general condition of the riparian corridor, an evaluation of floodplain development issues in the watershed, and water quality sampling at selected locations in the watershed.

Riparian Corridor

Forested riparian buffer along Cool Creek east of S. R. 431

The word riparian refers to anything connected with or immediately adjacent to the banks of a stream or other body of water. A riparian forest buffer encompasses the area from the streambank to the area of trees, shrubs, and herbaceous vegetation located upslope from the body of water. Buffers are established and managed to reduce the impact of adjacent land use. A buffer serves several important functions: it preserves the stream's natural characteristics, protects water quality, and improves habitat for plants and animals on land and in the water.

For a good portion of its main stem, Cool Creek has a healthy riparian forested buffer. From the mouth at the White River upstream to 116th Street, the stream corridor is forested. Between 116th Street and 126th Street, Cool Creek runs through a golf course. There are some forested areas along the creek in this reach, but not to the extent seen in other reaches. Upstream of 126th Street to approximately S. R. 32 there are healthy riparian buffers, though there are segments with limited forest cover.

No riparian buffer – Cool Creek south of 191st Street

Upstream of S. R. 32, Cool Creek has limited riparian vegetation and is farmed to the edge of the stream. Several segments of Cool Creek have been channelized and straightened. The photographs to the left illustrate the difference in riparian vegetation for the lower and upper reaches of Cool Creek. As the agricultural tracts in the upper watershed are developed, stream buffers (grass filter strips) should be considered.

Floodplain Development

A uniform policy preventing development in the floodplain would help protect water quality and protect against flooding.

Floodplain development concerns tie directly to preservation of the riparian buffers along Cool Creek (and its tributaries). Filling of floodplains can cause loss of flood storage and riparian habitat. As noted previously, Hamilton County has an ordinance that prohibits filling of land in the floodplains of its regulated drains. It may be appropriate for Carmel and Westfield to adopt similar policies for floodplains under their jurisdiction. This would provide a uniform policy and would help preserve existing riparian buffers. Many communities have adopted buffer ordinances to protect headwater streams where floodplains are often narrow and floodplain protection alone may not adequately protect buffer systems. This management practice would also help comply with IDEM water quality regulations.

Water Quality Sampling

186th Street Sampling Point

Stream sampling was performed at three locations in the watershed: 186th Street, 146th Street, and 116th Street. Upstream of 186th Street, the watershed is mostly agricultural and includes some large properties with horse farms. The 146th Street sampling point captures runoff from most of the Town of Westfield. The 116th Street sampling point represents most of the watershed.

Two wet weather events (03-25-02 and 8-19-02) and two dry weather events (06-21-02 and 09-09-02) were sampled between the spring and fall of 2002. The total rainfall on the two wet weather events was approximately 0.7 inches (3-25-02 event) and 2.9 inches (8-19-02 event). Grab samples were collected and tested for nutrients, oxygen demand, sediment, bacteria, and other parameters that are indicators of urban stormwater runoff pollution.

146th Street Sampling Point

Table 1, located at the end of this report, summarizes the results of the sampling program. The values shaded with yellow represent sample results that were somewhat elevated as compared to national averages found in the literature. The following observations and conclusions can be made from the sampling of Cool Creek:

116th Street Sampling Point

- The constituents and concentrations of pollutants found in Cool Creek are generally comparable to urban and urbanizing watersheds across the country.

- Nutrients appear to be somewhat higher than national averages. This could be the result of excess fertilizer use coupled with agricultural runoff from the upper watershed. Public education regarding proper lawn care may be an appropriate follow up activity.

- Suspended solids were very high for one of the sampled events, though this was an atypical storm event. Proper erosion and sediment control on construction sites, in addition to streambank restoration, will help to control suspended solids levels.

- Bacteria levels exceed those required for recreational contact. This finding was expected as nearly all urban watersheds have bacteria counts that greatly exceed health standards for swimming. Efforts should be made to track and reduce human sources of bacteria that may result from failing septic systems, illegal sanitary sewer connections, and other sources. Public education on proper disposal of pet waste would also be a best management practice to help reduce bacteria levels.

- Other management practices, such as enhanced stormwater management practices, will further reduce stormwater runoff pollution into Cool Creek and its tributaries.

SOLUTION DEVELOPMENT

Inadequate bridge – 171st St. over Cool Creek

The hydraulic analysis of the Cool Creek and its tributaries revealed that there are more severe conveyance problems in the upper reaches of Cool Creek and its immediate tributaries. Replacing undersized bridges and culverts will help to enhance public safety by reducing the likelihood of roadway overtopping during major storm events and to reduce floodplain impacts on property owners. Downstream reaches of the Cool Creek are characterized by severe streambank erosion. This is largely due to the following:

Culverts filled with sediment - Walter Street and Walter Court

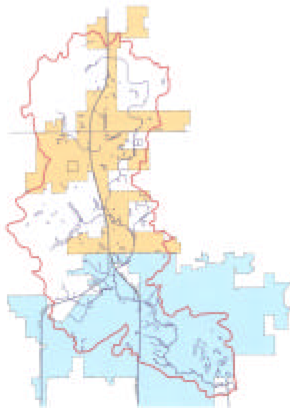
- *Aggregate effects of development in the upstream portions of the Cool Creek watershed*. Higher peak flows occur more frequently and for longer durations. These flows subject channel streambanks to excessive erosive forces. Although numerous detention ponds have been constructed in the watershed, they often do not adequately restrict flow rates for more frequent (i.e. 1-year and 2-year recurrence interval) rainfall events. These more frequent rainfall events generally dictate the tendency for channel erosion.

- *Development at or near existing channels*. Manmade features, such as residential structures, retaining walls, patios, foot bridges, and decks have been constructed within the floodplain and result in flow restrictions, higher velocities, and promote downstream streambank erosion.

Inadequate culverts – Carmel Drive over Hot Lick Creek

Proposed Solutions

The proposed solutions in the Cool Creek watershed consist of physical improvements to manmade and natural drainage features. These improvements were developed with careful consideration of the long-term health of the Cool Creek watershed, public safety, and enhancing stormwater quality. The preliminary design of bridge/culvert improvements was based on current INDOT design standards and/or the need to alleviate excessive headwater. The preliminary design of streambank restoration was based on emerging best practices for this type of improvement. Regional detention basin design was based on the need to significantly reduce flow rates resulting from frequent storm events and enhance in-stream water quality.



Proposed Improvements are as follows:

- Regrade roadway at 151st Street bridge to prevent roadway overtopping
- Replace 171st Street bridge and regrade roadway to prevent roadway overtopping
- Replace Gurley Street bridge (Anna Kendall Drain)
- Replace Cherry Street bridge (Anna Kendall Drain)
- Replace Carmel Drive culvert (Hot Lick Creek)
- Replace SR 32 (Main Street) culvert (J.M. Thompson Drain)
- Replace frontage road culvert immediately downstream of US 31 (Highway Run)
- Add a culvert to US 31 (Highway Run)
- Replace Walter Street and Walter Court culverts (Highway Run)
- Replace private drive culvert between Walter Street and Walter Court (Highway Run)
- Replace Thornberry Drive culvert (Highway Run)
- Implement seven (7) streambank restoration projects along select portions of the Cool Creek, Highway Run, and H.G. Kenyan Drain.
- Construct two (2) off-line regional detention basins to control the magnitude of stormwater flows resulting from frequent storm events and enhance instream water quality. Both detention ponds will be located in the upper portion of the Cool Creek watershed south of 171st Street and north of 186th Street.
- Anna Kendall In-Line Detention Pond. A 48-inch culvert under an abandoned railroad embankment creates a significant flood control impoundment upstream of Park Street on the Anna Kendall Drain. A breach has formed in the embankment, limiting its effectiveness. Improvements needed at this site include repairing the breach, upgrading the embankment, and installing a new control structure and emergency spillway.

The total estimated implementation cost for the recommended improvements will likely range from $8 million to $9 million. The approximate cost breakdown for bridge/culvert replacement, streambank restoration, and regional detention is 35 percent, 10 percent, and 55 percent, respectively.

Prioritization for the recommended improvements should be as follows:

1) Replace undersized bridges/culverts
2) Implement streambank restoration
3) Construct regional detention basins

CONCLUSIONS AND RECOMMENDATIONS

The following are conclusions and recommendations resulting from development of the Cool Creek Watershed Management Plan.

Conclusions

- Existing stormwater detention standards will effectively control peak flows and localized flooding as the watershed continues to develop, especially for larger storm events. However, the volume and duration of flow will increase, especially for the smaller more frequent storm events. This will lead to additional streambank erosion unless detention pond design requirements are modified to include provisions for restricting stormwater discharge resulting from the 1-year and 2-year recurrence interval rainfall events.

- The lower reaches of Cool Creek generally have a healthy forested riparian buffer. The upper reaches have been channelized and have limited riparian vegetation.

- The constituents and concentrations of pollutants found in the Cool Creek water quality sampling program are generally comparable to urban and urbanizing watersheds across the country. Best Management Practices such as public education, construction site erosion and sediment control, and enhanced detention standards will help reduce the concentrations of pollutants in stormwater runoff.

- Stormwater flooding problems are more pronounced in the upper reaches of Cool Creek and its immediate tributaries.

- The lower reaches of Cool Creek are subject to significant streambank erosion.

Recommendations

- *Implement consistent floodplain fill regulations in the watershed.* Hamilton County prohibits fill in the floodplain while Carmel and Westfield currently allow fill, provided certain conditions are met. A consistent policy prohibiting fill within the 100-year floodplain would help prevent flooding and water quality problems.

- *Implement a stream buffer ordinance.* Stream buffer preservation/enhancement such as grass filter strips, coupled with floodplain regulations, will help prevent flooding problems and improve water quality.

- *Update stormwater ordinances and design standards to more proactively address water quality*. Best Management Practices, both structural and non-structural, should be implemented to prevent or reduce urban runoff problems associated with existing and future development. Recommended practices include:

  – Modify detention policies to incorporate channel and water quality protection. Additional storage and more restrictive release rates for smaller storms will help capture stormwater runoff pollutants and reduce streambank erosion to receiving waters.
  – Identify and protect critical conservation areas such as wetlands and floodplains.
  – Encourage natural drainage protection when siting developments.
  – Utilize sound site planning practices.
  – Utilize other structural and non-structural management practices as appropriate such as porous pavement, sand filters, infiltration practices, water quality swales, manufactured devices, vegetated filter strips, and bioretention areas.

- *Construct the capital projects identified in this report.* Capital projects include eleven (11) bridge and culvert improvements, seven (7) streambank restoration projects, two (2) regional detention basins, and improvements to one (1) existing regional detention facility (Anna Kendall). These projects will enhance public safety, improve water quality, and represent a significant step towards achieving long-term environmental health for Cool Creek.

- *Use this report as a reference condition.* The findings in this report should be used as a reference condition to compare to future watershed and stream conditions and evaluate the effectiveness of stormwater management practices.

TABLE 4-1
STREAM SAMPLING RESULTS
COOL CREEK WATERSHED MANAGEMENT PLAN

Parameter		Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Steet Crossing				186th Street Crossing			
			Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
			06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD	mg/L	12[1]	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD	mg/L	91[1]	<10	<10	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl	mg/L	2.35[1]	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate	mg/L	0.96[1]	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	**1.8**	0.65	**2.2**	1.2
Nitrogen, Ammonia	mg/L	0.26 - 1.1[2]	<0.10	<0.10	0.88	0.14	<0.10	<0.10	**5.1**	0.16	<0.10	<0.10	**4.3**	0.29
Nitrogen, Total	mg/L	3.31[1]	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic	mg/L	1.25[3]	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved	mg/L	0.16[1]	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids	mg/L	100[4]	<5	<5	120	**490**	<5	<5	61	**580**	<5	10	11	160
Dissolved Solids	mg/L	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E coli	/100 mL	11,000[5]	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus	/100 mL	35,000[5]	13	3	120	920	12	<1	240	960	5	4	<10	1700
Chromium, Hex	mg/L	0.007[6]	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol	mg/L	0.008 - 0.115[6]	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper	mg/L	0.047[1]	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel	mg/L	0.012[6]	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.176[1]	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

(1) Nationwide Urban Runoff Program. 2300 monitored storms at 22 sites across the nation. US EPA 1983.
(2) Range is for newer suburban sites and older urban areas, as reported by Metropolitan Washington Council of Governments, 1987.
(3) Newer suburban sites, as reported by Metropolitan Washington Council of Governments, 1987.
(4) U. S. EPA database for general urban runoff.
(5) Center for Watershed Protection database of 34 recent urban stormwater monitoring studies, 1999.
(6) Metro Seattle as reported in Fundamental of Urban Runoff Management: Technical and Institutional Issues, Terrene Institute, 1994.
N/R = Not Reported
Cells shaded yellow with bold border indicate values significantly higher than national averages found in the literature.